FOSSIL VERTEBRATE FAUNAS FROM THE LAKE VICTORIA REGION, S.W. NEW SOUTH WALES, AUSTRALIA

By Larry G. Marshall
Zoology Department, Monash University, Victoria*

Abstract

Fossil vertebrate localities and faunas in the Lake Victoria region of S.W. New South Wales, Australia, are described. The oldest fossil bearing deposit, the late Pliocene or early Pleistocene Moorna Formation and associated Chowilla Sand have yielded specimens of *Neoceratodus* sp., *Emydura macquarrii,* several species of small dasyurid, specimens of *Glaucodon* cf. *G. ballaratensis,* a species of *Protemnodon* which compares closely with *P.* cf. *P. otibandus* from the late Pliocene or early Pleistocene Chinchilla Sand in SE. Queensland, specimens of *Lagostrophus* cf *L. fasciatus,* species of *Petrogale, Macropus, Osphranter, Sthenurus, Bettongia, Diprotodon, Lasiorhinus,* a peramelid, at least two species of pseudomyine rodents and a species of *Rattus* cf. *R. lutreolus.* It is shown that the holotype of *Zygomaturus victoriae* (Owen) 1872 may have been collected from these sediments. The late Pliocene or early Pleistocene Blanchetown Clay has yielded species of *Neoceratodus, Thylacoleo, Phascolonus, Bettongia, Sthenurus,* a diprotodontid, and a rodent. The late Pleistocene Rufus Formation has yielded species of *Dasycercus, Sarcophilus, Thylacinus, Phascolonus, Lasiorhinus, Bettongia, Procoptodon, Onychogalea, Macropus,* and *Leporillus.* A large species of macropod and a species of *Phascolonus* were collected from the late Pleistocene Monoman Formation. The lunette on the E. side of Lake Victoria has yielded a large, diverse fauna of late Pleistocene —Holocene age, that includes such extinct species as *Protemnodon anak, P. brehus, Procoptodon goliah, Sthenurus andersoni, S. atlas, S. tindalei, Thylacoleo carnifex, Phascolonus gigas, Macropus ferragus, and Diprotodon optatum.* The oldest C14 date obtained for an occupation site of Aboriginal man at Lake Victoria is 18,800±800 yr B.P. (GaK-2514). No evidence was found of a direct association of man with late Pleistocene megafaunal species at Lake Victoria.

Introduction

The first reported discovery of fossil vertebrates at Lake Victoria, N.S.W. was made in September 1967 by Mr. Max Tulloch of Mildura and Mr. Hal Loftus of Cheltenham. During a camping trip to the area they discovered, and partially excavated, the skeleton of a large macropod from the lunette on the NE. side of Lake Victoria. Mr. Hal Loftus subsequently sent the specimen to Mr. Colin Macrae of Beaumaris who recognized the material as fossil, and conveyed this information to Mr. Thomas Darragh, Curator of Fossils at the National Museum of Victoria. This specimen was later identified as *Procoptodon goliah* (P28277). Loftus provided Darragh with a map of the collection site, and on 17-26 October 1967, Darragh, accompanied by Mr. Ken Simpson (Field Officer) and Mr. Donald Shanks, went to Lake Victoria and relocated the specimen. The remaining portion of the skeleton had since weathered out of the matrix and was greatly damaged; however, other specimens of *Procoptodon, Bettongia, Diprotodon, Thylacoleo,* and *Lasiorhinus* were collected. The site was then recognized as having great potential warranting further investigation.

At this time, the National Museum of Victoria was already involved in a large reconnaissance program (the Chowilla Project) to systematically study the region which was to be flooded behind the proposed Chowilla Dam. Lake Victoria was part of the holding basin (Gill, This Memoir). Mr. E. D. Gill, Deputy Director of the National Museum of Victoria supervised the salvage projects. During a series of field trips a large collection of fossils was made from the Lake Victoria lunette. Stratigraphic studies of surrounding areas and older sediments subsequently led to the discovery of additional deposits containing fossil vertebrate

* Now Dept. Paleontology, University of California, Berkeley, California, U.S.A.

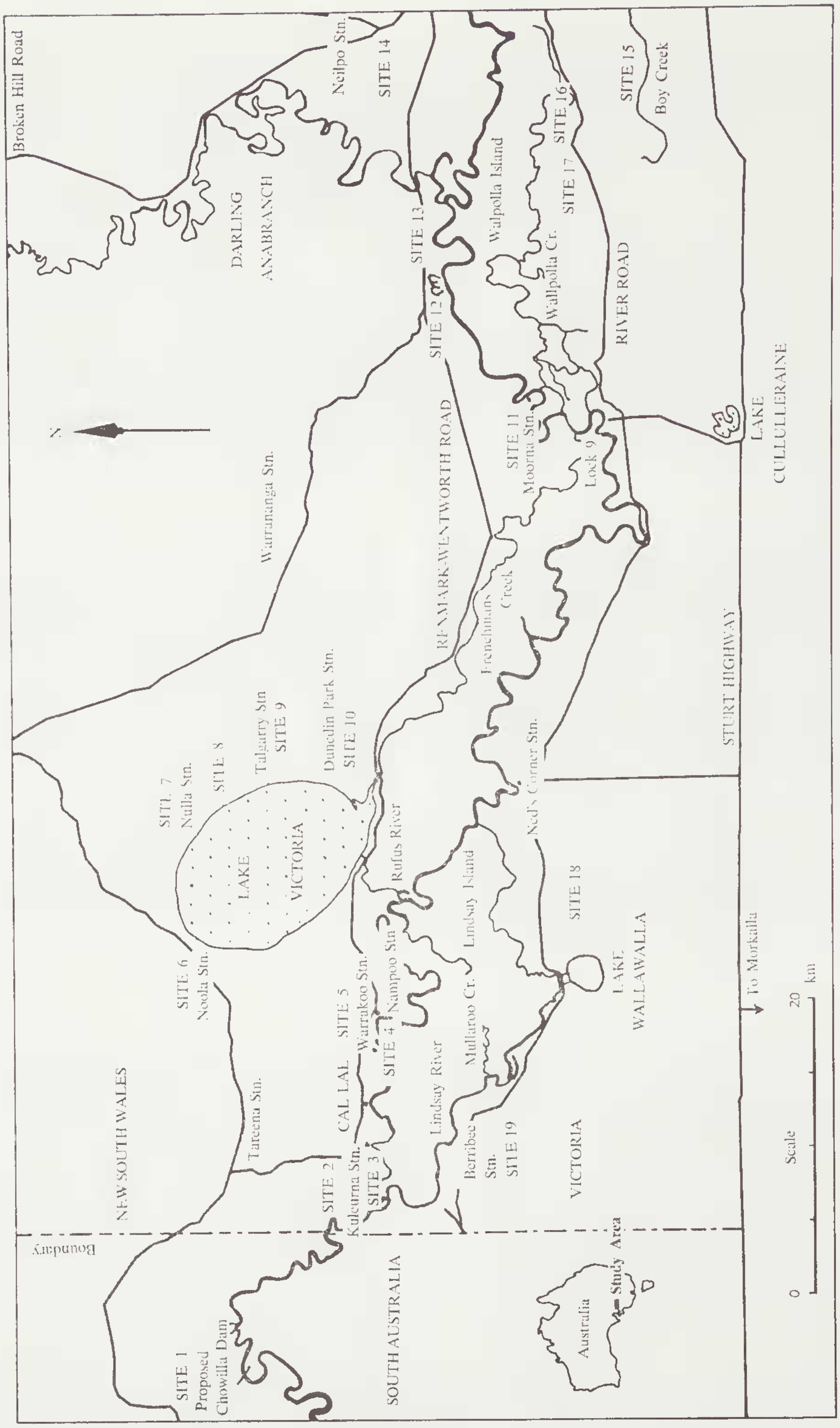

Fig. 1—Map of the Lake Victoria area showing the fossil vertebrate localities discussed in the text.

material. A total of nine localities has yielded an abundance of fossil vertebrates (Fig. 1; see appendix on Sites). The fossil bearing deposits are of late Pliocene to Holocene age (Fig. 2).

The fossil vertebrate collections were subsequently made available for systematic study to Professor J. W. Warren, Department of Zoology, Monash University. In November 1970 these materials were turned over to me to form the basis for a Post Graduate degree under the direction of Professor Warren. My thesis includes a systematic and phylogenetic study of the late Pleistocene fauna from the Lake Victoria lunette. During 1971, Warren, Simpson and myself returned to this area on several occasions and made additional collections.

This paper presents a preliminary report of the fossil vertebrate localities and faunas discovered in conjunction with the Chowilla Project, but includes mention of other fossil mammal occurrences from the Murray River Basin. These localities occur in the vicinity of Lake Victoria, New South Wales, delimited to the E. by Mildura, Victoria, and to the W. by Renmark, South Australia.

Format

Although it is preferable to defer publication pending completion of an in depth systematic

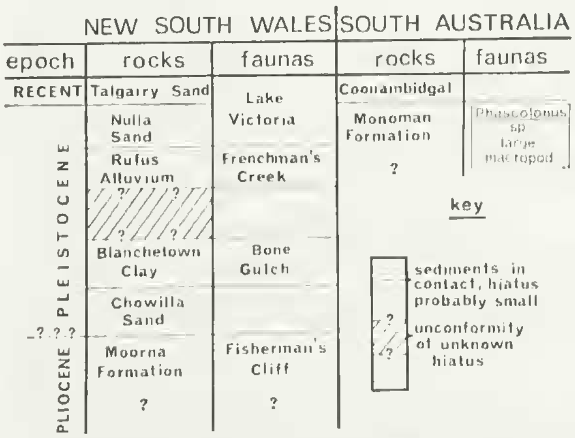

Fig. 2—Chart showing the stratigraphic relationship of the rock units and faunas discussed in the text. The proposed ages are based on both rock-stratigraphic and biostratigraphic information. Compare this figure with Fig. 2 of Stirton *et al.*, 1968.

study, the interest expressed in these localities and faunas warrants a preliminary report. The species list given for Sites 7-10 is extracted directly from my dissertation. A systematic diagnosis of these species is complete for most of the taxa, and will appear at a later date. The extinct species from Site 13 have been compared with the type specimens (e.g. *Protemnodon otibandus,* and *Glaucodon ballaratensis)* and many of the smaller forms (e.g. *Dasyurus, Lagostrophus* and *Rattus*) compare well with living species. Several of the smaller forms probably represent new taxa (e.g. small dasyurid cf. *Dasyuroides* or *Dasycercus)* for which phylogenetic relationships are here proposed. A complete analysis of the fauna from Site 13 will not be made available for four or five years and I have given preliminary descriptions of some of the more important taxa at this time. For this reason a disparity exists between the amount of attention received by the fauna from Site 13 and those from Sites 7-10 and 12.

Higher mammalian taxonomic categories follow those adopted by Butler *et al.* (1967) and taxonomy below the family level largely follows Ride (1970). All specimens are registered and housed in the National Museum of Victoria (NMV). All measurements in the text are in millimetres and the scales appearing on the Plates and Figures are all in centimetre gradations. I have followed Stirton *et al.* (1968, pp. 1-2) in separating rock stratigraphic and biostratigraphic names. Grid references are given for each locality based on the Australian Army Survey (1:250,000) Mildura map SI-54-11, Anabranch SI-54-7, and Renmark SI-54-10, Edition 1, Series R 502.

Methods

At Sites 7-10, 13 collecting techniques initially involved walking over the area and picking up float material (Pl. 14, fig. 3). Minor excavations were made to uncover partially exposed specimens (Pl. 14, figs. 1-2, 4). During 13-21 August 1971, we employed the wet sieve technique (Hibbard 1949) at Site 13 in an attempt to recover smaller elements. Samples of the upper coarser fraction of the Moorna Formation were first washed in fine meshed screens to remove clay particles and break down any consolidated masses, dried, and taken back to the laboratory where detailed examination and sorting was accompanied by use of a binocular microscope. This method proved to be successful as only then were teeth of rodent, small dasyurid, and small macropod found. Sorting in the laboratory revealed that some samples yielded far greater numbers of specimens than others, suggesting the occurrence of local concentrations. No wet sieved samples of the lower portion of the Moorna Formation, Chowilla Sand or Blanchetown Clay were taken at Site 13. At Site 12 all fossil material was obtained by quarrying operations, and not by wet sieving.

At Sites 7-9 along the Lake Victoria lunette, numbered stakes were placed by Gill and Simpson at the E. end of each erosion gully. Collection localities were marked in reference to these points. More important finds (larger, more complete skeletons) were surveyed to one of the four N.M.V. bench marks (Gill, This *Memoir*).

Float specimens were sorted into age groups based on degree of leaching and presence or absence of adhering carbonate and sand, following the deductions employed by Tedford (1955, 1967). Specimens collected at Site 10 were labelled as float or in situ, and the precise localities of the more complete specimens were surveyed to an N.M.V. bench mark.

The geology of the region is treated by Gill (This *Memoir*). The faunas are considered in ascending order of age in the following pages.

Site 13, Moorna Formation (late Pliocene or early Pleistocene)

Grid reference 469,788

Stratigraphy

The Moorna Formation consists of coarse stream channel sediments at this site. Many of the fossil specimens, both bones and teeth, have been worn by stream action, and the finer dental patterns have often been lost. Articulations have been largely dissociated, and most material consists of isolated tooth and bone fragments. The bone is a rich brown to yellow with dendritic manganese staining. The bone surfaces are usually smooth and the smaller cancellous vacuities are not filled with sediments. Most of the specimens are mineralized. For details of stratigraphy and grain size analysis see Gill (This *Memoir*). At this site the coarse gray Moorna sediments grade up into yellow finer better sorted Chowilla Sand, but for the present purpose both are referred to as the Moorna Formation.

Age

Absence of volcanic rocks in the study area prevents chronometric dating by isotopic methods. Stratigraphic and geomorphic methods have been used by Gill (This *Memoir*) in proposing a late Pliocene age for the Moorna Formation.

The stage of evolution of the diverse mammalian fauna from these sediments offers an independent assessment of their age. The age of the deposit from which the holotype of *Glaucodon ballaratensis* was collected is interpreted by Gill (1957, p. 191) as late Pliocene or early Pleistocene. Stirton (1957, p. 133) argued that if *Glaucodon* was in the direct line of ancestry of *Sarcophilus* then the age of the beds from which *Glaucodon* was collected may be as old as "late Miocene or slightly older". At the time Stirton believed that species of *Sarcophilus* were represented in Pliocene deposits. Marshall and Bartholomai (1973) have shown that there are no specimens of this genus *(Sarcophilus)* which may be definitely assigned to Pliocene or even earlier than late Pleistocene age. *Glaucodon* may therefore be regarded as in the direct line of ancestry to *Sarcophilus* and still come from deposits of a Pliocene-Pleistocene age. As the Moorna specimen of *Glaucodon* (P28268) is probably conspecific with that of the holotype (P16136) (see below) the deposits are deemed to be of comparable age.

Aziz-ur-Rahman and McDougall (1972) recently obtained a K-Ar date of 2·1 m.y. on a sample of basalt from the West Berry Consols Mine No. 1 Bore in Victoria. The Smeaton locality, containing *Glaucodon ballaratensis* is located 4·2 km to the north. The sediments from which *Glaucodon* was taken are younger than the basalts, making *Glaucodon* "latest Pliocene or younger in age" (ibid.).

Species of *Protemnodon* have been found to be widely distributed in deposits of Pliocene and Pleistocene age, and are proving to be useful index fossils (Plane 1972). The Moorna specimen of *Protemnodon* (P28266) agrees best with specimens of *P.* cf. *P. otibandus* from the Chinchilla Sand of SE. Queensland (see below) which are considered to be late Pliocene or early Pleistocene in age (Stirton *et al.* 1968, pp. 17-18, Woods 1962).

Most of the other species from the Moorna Formation are too poorly known at present to be of use as index fossils. Many of the smaller macropodids appear to be conspecific with living species, while others are probably the direct ancestors of living species. The age based on biostratigraphic and rock-stratigraphic grounds suggests a late Pliocene or early Pleistocene age. It is reasonable to postulate that we are dealing with a fauna whose age may be roughly equated with the Villafranchian of Europe or the Blancan of North America.

The fauna from this locality is here designated the Fisherman's Cliff Local Fauna.

Fisherman's Cliff Local Fauna
(late Pliocene or early Pleistocene)

Class Gastropoda
Order Basommatophora
Family Lymnaeidae

The species *Lymnaea* cf. *L. tomentosa* is represented by a single specimen (P29444) determined by Mr. T. A. Darragh.

Class Osteichthyes
Superorder Teleostei

Numerous vertebrae, neural spines, otoliths and skull fragments apparently representing several species of bony fish.

Order Dipnoi
Family Ceratodontidae

A species of *Neoceratodus* is represented by a single tooth plate (P28879).

Class Reptilia
Order Chelonia
Family Chelyidae

A relatively complete, associated carapace and plastron (P30775) agrees well with the living species *Emydura macquarrii* (identified by Professor J. W. Warren). This species presently occurs only in the Murray River and its tributaries (Rawlinson 1971, p. 21) but a specimen from the mid-Tertiary of Tasmania showing affinities to this species (Warren 1969) suggests a wider distribution in the past.

Class Aves
Order Casuariiformes

Several egg shell fragments (P28881) indicate the presence of a large ratite. The convex surface is granulated and the concave surface is smooth, a character of the shells of living species of both *Dromaeus* and *Casuarinus*.

Class Mammalia
Superorder Marsupialia
Order Marsupicarnivora

Dasyurus cf. *D. hallucatus* is represented by a single M^3 (P28889). The M^3 of *D. hallucatus* (C684) is easily separated from the slightly larger species of *Dasyurus* (e.g. *D. viverrinus* C6062, *D. geoffroii* C6084, and *D. maculatus* C2165) by the proportionately smaller metastylar ridge (terminology after Clemens 1966, p. 3). A fragment of a left M^2 or M^3 (P28890), has a long metastylar ridge, and compares closely in size with *D. geoffroii* (C6084) and *D. viverrinus* (C6062). A right M_3 (P29428) agrees closely in size and morphology with *D. geoffroii* (C6084). The tooth is narrow relative to its length, the talonid is narrower than the trigonid, and the protoconid is set slightly anteriad of the metaconid. In *D. viverrinus* (C6062) the tooth is broad relative to its length, the talonid is as wide as the trigonid and the protoconid usually lies directly linguad to the metaconid. Judging from the stage of evolution of the fauna as a whole this specimen may prove to bear closer affinities to *D. dunmalli* from the late Pliocene or early Pleistocene Chinchilla Sand of SE. Queensland (Bartholomai 1971) although an entire dentary is needed from Site 13 to support this speculation.

A species of the genus *Glaucodon* is represented by a left ramus with M_{1-4}, and alveoli

TABLE 1

Comparison of holotype of *Glaucodon ballaratensis* (P16136) with P28268 from Site 13

Specimen	M_1		M_2		M_3		M_4			Width of Mandible Below M_4	Depth of Mandible Below M_4
	L	MW	L	MW	L	MW	L	MW	M_{1-4}		
P16136	7·5	4·2	—	—	—	—	9·9	5·7	34·0	7·0	17·0
P28268	7·7	—	8·6	5·7	9·7	6·0	10·4	5·9	36·5	8·0	19·3

Abbreviation: L=length, MW=maximum width

of the incisor, canine, and premolars (P28268) (Pl. 15, figs. 3-4) and an isolated M^2 (P28684) (Pl. 15, figs. 1-2). The former specimen compares closely with the holotype of *G. ballaratensis* (Stirton 1957). These specimens are compared in Table 1.

P28268 is more robust in the mandible and the teeth show greater apical cusp wear than P16136. The holotype (P16136) is a young animal in which the M_4 shows little evidence of wear, while the large amount of occlusal wear in P28268 indicates that it represents an older individual. In P28268, the talonids are well developed in M_{2-3}, proportionately larger than in *Sarcophilus harrisii* (C6239) and smaller than in *Dasyurus maculatus* (C2165). These specimens (P16136, P28268) are compared following the procedures set forth by Simpson *et al.* (1960, p. 210) for comparing two isolated specimens possibly of a single species. The results, using the raw data presented in Table 1, are given in Table 2.

TABLE 2

Comparison of holotype of *Glaucodon ballaratensis* (P16136) with a specimen of *Glaucodon* (P28268) from Site 13

Dimension	M_1	M_4		M_{1-4}	Width of Mandible Below M_4	Depth of Mandible Below M_4
	L	L	MW			
log difference	·0114	·0214	·0150	·0308	·0580	·0552
minimum value of V[a]	1	2	1	2	3	3

[a] values of V and D were taken from Simpson *et al.* 1960, p. 209.

Abbreviations: L=length, MW=maximum width

Linear dimensions with values of V greater than 5-6 usually warrant specific distinction, although values of V between 3-4 are commonly used (ibid). Keeping in mind the ontogenetic differences of these specimens and absence of notable morphological differences, it appears probable that they are conspecific.

A small species of dasyurid compares closely in size and molar morphology with *Dasyuroides byrnei* (C458) and *Dasycercus cristicauda* (C655). It is represented by a right edentulous ramus fragment with alveolus of C-M_1 (P28886) and a right ramus fragment with M_{2-4} and alveolus of M_1 (P28888) (Pl. 15, figs. 5-6). A comparison of the two rami fragments shows that in P28886 there is a single alveolus (rudimentary P_3?) between those for M_1 and P_2. This species is regarded as a possible ancestral form of *Dasyuroides* or *Dasycercus* (or both). An isolated right M_3 (P28857) shows the hypoconid portion of the talonid set further posteriad than the entoconid and there is no trace of a hypoconulid. This specimen may be either a variant of the same species as P28888, or may represent a second species or genus of small dasyurid.

Order Peramelina

Family Peramelidae

The bandicoots are represented by a single right M^2? (P28686) (Pl. 15, figs. 8-9). The striking feature of this specimen is the presence of five prominent stylar cusps, with cusp $B > D > C > A \simeq E$ (see Clemens 1966, p. 3 for stylar cusp terminology).

Order Diprotodonta

Family Vombatidae

Several molar fragments (P29447, P29448) indicate the presence of a species similar in size and morphology to the living species of *Lasiorhinus*. The labial edge of the molar lobes are well rounded, not sharp as in species of *Vombatus* (Merrilees 1967, p. 407).

Family Macropodidae

Subfamily Potorinae

A right M_1 (P29416) and fragment of a P^3 (P29417) are tentatively referred to a species of *Bettongia*.

Subfamily Sthenurinae

Two molar fragments (P29422, P29423) are readily assigned to a species of the genus *Sthenurus* by the complex ornamentation on the enamel surface (Tedford 1966). A large right mesectocuneiform (P29424) indicates the presence of a species of this subfamily, and shows that the monodactylous condition which is characteristic of the late Pleistocene members of this subfamily (Tedford 1967, p. 73) was well developed by late Pliocene or early Pleistocene times.

Subfamily Macropodinae

Members of this subfamily are abundant in both numbers and species, representing the most diverse group in the fauna. *Lagostrophus* cf. *L. fasciatus* is represented by two upper molars (P28891, P28892) that are easily identified as such by the medial vertical ridge on the posterior face of the metaloph. A species of *Petrogale* is represented by an upper (P29418) and lower (P29419) P3. Numerous small molars record the presence of species of the size of *Onychogalea, Lagorchestes,* and possibly some of the smaller species of *Macropus.* It is, however, difficult to assign these elements to specific or even generic rank without associated premolars.

The protoloph fragment of an upper molar (P29420) is large, has an incipiently developed (although well defined) forelink, and the labial side of the anterior basal cingular valley is enclosed labially by a connection between the base of the paracone and anterior cingulum. These features are characteristic of species of *Osphranter*.

A species of *Protemnodon* is represented by an isolated fragment of a P_3 (P29421) and a left ramus with the greater part of M_{3-4} preserved (P28266) Pl. 15, fig. 7). The molars are broad for their length, resembling *P. brehus, P. raechus,* and *P. otibandus* in contrast to the

TABLE 3

Comparison of *Protemnodon* sp. (P28266) from Site 13 with a sample of *P.* cf. *P. otibandus* from the Chinchilla Sand, Queensland, a sample of *P. otibandus* from the Otibanda Formation, New Guinea, and a specimen of *P. brehus* from Lake Victoria (Site 8 (P28660).

	M_2 L	L	M^3 AW	PW	L	M^4 AW	PW
Specimen P28266	15·2[a]	17·0	12·4	11·0[a]	16·5	11·5[a]	10·1
Chinchilla Sand[d]	11·8-15·5	14·8-16·9	10·3-12·0	—	15·5-17·9	10·5-12·0	—
Otibanda Formation[b]	10·9-13·2	11·8-14·0	10·1-10·5	9·8-10·4	13·3-14·4	10·0-10·5	9·8-10·0
P28660 Lake Victoria[c]	15·2	17·1	13·4[a]	13·2[a]	18·7	—	12·7

[a] approximate
[b] data from Plane 1967
[c] *Protemnodon brehus*
[d] courtesy of Mr. A. Bartholomai
Abbreviations: L=length, AW=anterior width, PW=posterior width.

smaller and proportionately elongated molars of *P. anak* and *P. buloloensis.* P28266 is compared with specimens of *P. otibandus* from the Awe Fauna of New Guinea, material referable to *P.* cf. *P. otibandus* (Mr. Alan Bartholomai pers. comm., Plane 1972) from the late Pliocene or early Pleistocene Chinchilla Sand, SE. Queensland, and a specimen of *P. brehus* from Site 8 at Lake Victoria (Table 3). In stage of evolution P28266 agrees best with the Chinchilla sample of *P.* cf. *P. otibandus.* It is smaller than the late Pleistocene *P. brehus* and larger than the medial Pliocene population of *P. otibandus* from New Guinea.

Family Diprotodontidae

A fragment of the posterior face of the metaloph of an upper molar (P28883) is probably referable to a species of *Diprotodon.* As in *Diprotodon,* a well defined posterior basal cingulum is present and the crown shows the extreme hypsodont development. The enamel shows the "reticulo-punctate" pitting (Huxley 1862) although abrasion due to stream action has reduced the expression of this character.

Remains of *Diprotodon* sp. are also recorded from the late Pliocene or early Pleistocene Chinchilla Sand, Queensland (Woods 1962, p. 46).

The holotype of *Zygomaturus victoriae* (Owen) 1872 was collected from a well "45-60 feet" below the ground surface, in the SW. corner of N.S.W. near the borders of Victoria and S. Australia (Mr. J. A. Mahoney and Dr. W. D. L. Ride, pers. comm.). Owen (1877, p. 271) records that the holotype (South Australian Museum P4986) is a "rich brownish-yellow" and "the minute cancelli are vacant, not filled up with mineralised matter". The type of preservation suggests derivation from the Moorna Formation. If this proves to be true, the phylogenetic position of this species will need re-evaluation as it was previously recognized as a Pleistocene species (Simpson 1930, p. 69). It should thus be compared with Pliocene zygomaturine species such as *Z. keani* (Stirton 1967) from the Mampuwordu Sands at Lake Palankarinna, S. Australia.

Infraclass Eutheria

Order Rodentia

Family Muridae

Next to macropods, rodents constitute the largest number of individuals in the fauna. This group is represented by 27 molars, 33 incisor fragments, one calcaneum, one astragalus, one caudal vertebra, and two podial elements. Two species (possibly genera) of pseudomyine rodents are indicated by differences in loph arrangement of M_1. A single M_1 (P28893) is referable to a species of the genus *Rattus.* The cheek teeth of *Rattus* are easily separated from other Australian murids by the characteristic root pattern, noted by Jones (1922), and Ride (1960). The M_1 of species of *Rattus* has a large root below the posterior loph, one slightly smaller below the anterior loph and two smaller (one labial and one lingual) roots under the medial loph, in contrast to the double rooted arrangement in other Australian murids. P28893 has the characteristic *Rattus* root pattern. This tooth lacks a "talonid" (=posterolophid of Schram and Turnbull 1970), and in this respect agrees with the mainland *R. lutreolus,* while *R. assimilus, R. villosissimus, R. tunneyi,* and *R. fuscipes* have this feature well developed unless secondarily lost through wear (Mr. J. A. Mahoney, pers. comm.). Although P28893 shows a striking resemblance to *R. lutreolus,* it is here referred to the genus *Rattus* with specific allocation deferred pending discovery of additional material.

Rodents of pre-late Pleistocene age are recorded from the medial Pliocene Awe Fauna, New Guinea (Plane 1967, p. 56), and early Pleistocene Kanunka Fauna, South Australia (Stirton *et al.* 1961, p. 43). The abundance of rodents in the Fisherman's Cliff Local Fauna shows this group to be well established by late Pliocene or early Pleistocene times, and the diversity indicates an earlier radiation. Turnbull and Lundelius (1970, pp. 75-76) report rodents as absent from the medial Pliocene Hamilton Fauna of Western Victoria. Considering the abundance of small sized marsupials in that fauna this absence may be real. If this is true, then the time of entry of rodents onto the Australian continent possibly occurred in the interval between post-Hamilton and pre-Moorna times.

Site 12, Blanchetown Clay (late Pliocene or early Pleistocene)

Grid reference 463,785

Stratigraphy

Outcrops of greenish grey mudstones are widespread along the Murray and Darling Rivers and are referred to as the Blanchetown Clay (Firman 1965). They are known from a number of localities in NW. Victoria, SW. New South Wales, and E. South Australia. At this locality they are interrupted by lenses of channel sands and ostracod coquina bands.

The Blanchetown Clay overlies the Chowilla Sand at Site 13. The former is of lacustrine origin, the latter is a channel and floodplain deposit. The two are shown to interdigitate at other localities (Gill, This *Memoir*). The relationship shown in Fig. 2 represents the relationship of these deposits at Site 12 and Site 13 only, and is not intended to express their relationship elsewhere.

The skeleton of a small diprotodontid was found *in situ* in the clay layer at Site 12. Clay penetrated into the cancellous regions of the bone, and compaction has deformed the original shape of these elements. Fish and mammal remains are abundant in interdigitated sand lenses. The material is fragmentary and the finds to date consist of isolated fish vertebrae, spines, and mammal teeth.

Age

Stratigraphically the Blanchetown Clay is regarded as early medial Pleistocene (Firman 1965, 1966), early Pleistocene (Lawrence 1966), or late Pliocene/early Pleistocene (Gill, This *Memoir*). These differences may be partially due to lack of agreed definition of the Pliocene-Pleistocene boundary. The sparse mammal fauna is of little use at the present time in determining the age.

Firman (1967) records remains of species of *Diprotodon* and *Macropus* in this formation in South Australia.

The fossil fauna from this locality is here designated as the Bone Gulch Local Fauna.

Bone Gulch Local Fauna (late Pliocene or early Pleistocene)

Class Crustacea

Order Decapoda

Crayfish are represented by two gastroliths (P29413, P29414).

Class Osteichthyes

Superorder Teleostei

Bony fish are the most abundant element in the fauna and are represented by numerous vertebrae of varying sizes, neural spines, and skull fragments.

Order Dipnoi

Family Ceratodontidae

Several dozen lungfish tooth plates compare closely with the living Australian species *Neoceratodus forsteri*.

Class Reptilia

Order Chelonia

Family Chelyidae

Turtles are represented by numerous plastron and carapace fragments.

Class Mammalia

Superorder Marsupialia

Order Diprotodonta

Family Thylacoleonidae

A species of *Thylacoleo* is represented by the anterior face of a left M^1 (P28885).

Family Vombatidae

A large fragment of a lower molar (P26880) indicates the presence of a large wombat. The enamel has the prominent pitted and vertical ridging of species of *Phascolonus*. The size and morphology suggest affinities with *P. magnus* (Mr. H. E. Wilkinson pers. comm.).

Family Macropodidae

Subfamily Potorinae

The rat kangaroos are represented by a single fragment of a right M_2 or M_3 (P26875). The tooth compares best with species of *Bettongia*. The hypoconid is a large cusp while the entoconid is small and confluent with a spur extending lingually from the former. This disparity in size between the labial and lingual cusps distinguishes this tooth from the subequal cusp arrangement seen in species of *Potorus*.

The posterior basal cingulum is deep and situated linguad of centre. A small spur occurs medially on the anterior face of the hypolophid and extends slightly linguad into the interloph valley.

Subfamily Sthenurinae

The anterior labial edge of an upper molar (P26882) has the ornamented ridges of the anterior protoloph face and anterior cingular valley which is characteristic of species of *Sthenurus.*

Subfamily Macropodinae

This subfamily is represented by numerous tooth fragments, although all are undeterminable as to the species represented.

Family Diprotodontidae

A single molar fragment (P26877) is referable to this family. The enamel has the "reticulo-punctate or worm eaten" look which is characteristic of the teeth of *Diprotodon* (Huxley 1862, p. 425) but is not as distinctly developed as in the late Pleistocene forms of this genus. A reasonably complete articulated skeleton of a small diprotodontid (P29487) was found *in situ* but lack of associated dentition and poor preservation of the skeletal material deters even tentative generic identification at the present time.

Infraclass Eutheria
Order Rodentia
Family Muridae

Rodents are represented by a single incisor fragment (P29415).

Sites 8, 10, 15, Rufus Formation (late Pleistocene)

Grid reference (Site 8) 434,803
Grid reference (Site 10) 436,794
Grid reference (Site 15) 485,774

Stratigraphy and Age

Overlying the Blanchetown Clay in the incised river tract of the Murray River W. of Mildura are red argillaceous sands of fluviatile origin, termed the Rufus Formation (Gill, This Memoir).

Vertebrate fossils have been found at three localities, Sites 8, 10, and 15. The bones are encrusted with a thin layer of carbonate, which is red like the matrix. The bone tends to remain white although it may have a pink tint. Many of the specimens have minute cracks which are filled with calcite.

Although a great deal of the fossil material was collected as isolated specimens, the percentage of articulated elements was high. Of particular interest are the partial skeletons of *Phascolonus gigas* (P28845, Site 10), *Procoptodon goliah* (P30776, Site 15,) and a nearly 80% complete skeleton of a large species of *Macropus* cf. *M. titan* (Site 10). The presence of this relatively large number of partial skeletons (compare with the total minimum number of individuals, see below) may be explained by their accumulation during a period of flooding, with the deposition of bloated carcases in back water areas and consequently in an environment which was congenial for immediate preservation. Kurten (1953, pp. 69-73) reported similar occurrences for local accumulations of European fossil assemblages.

On biostratigraphic grounds the age of the Rufus Formation is placed as late Pleistocene.

The presence of *Macropus siva* in the fauna from Site 10 is of special interest. This species is recorded only from its type locality in the late Pleistocene deposits of the Eastern Darling Downs, Queensland (De Vis 1895, pp. 113-114) and two specimens from late Pleistocene deposits in Mt. Hamilton Cave SW. Victoria are referred by Wakefield (1963, p. 326) to *M.* cf. *M. siva.* This species is abundant in the fossil collections from Wellington Caves in the Australian Museum (AMF47092) and it is the most abundant medium sized macropodid (P29579) in the fossil collection from the late Pleistocene dark chocolate clay beds at the Keilor Terrace archaeological site (Gallus excavation) in S. Victoria. A specimen from Lake Colongulac, Victoria (P30215) is assignable to this species.

The numbers following the generic and specific names given below represent the minimum number of individuals of each taxon from Site 10. The fauna from the three localities in the Rufus Formation is designated here as the Frenchman's Creek Fauna, the name being derived from Frenchman's Creek, which lies just S. of Site 10.

Frenchman's Creek Fauna (late Pleistocene)

Site 10

Class Gastropoda
- Order Stylomatophora
  - Family Camaenidae
    - *Chloritis* sp. (P30211) determined by Dr. Brian Smith.

Class Aves
- Order Casuariiformes
  - Fragments of large egg shells (P30210).

Class Mammalia
- Infraclass Metatheria
  - Superorder Marsupialia
    - Order Marsupicarnivora
      - Family Dasyuridae
        - *Dasycercus cristicauda* (1) (P29427)
        - *Sarcophilus laniarius* (1) (P28408)
- Family Thylacinidae
  - *Thylacinus cynocephalus* (1) (P28403)

Order Diprotodonta
- Family Vombatidae
  - *Phascolonus gigas* (1) (P28876)
  - *Lasiorhinus krefftii* (3) (P30212)
- Family Macropodidae
  - Subfamily Potorinae
    - *Bettongia lesueur* (3) (P28641)
  - Subfamily Sthenurinae
    - *Procoptodon goliah* (1) (P28286)
  - Subfamily Macropodinae
    - *Onychogalea fraenata* (3) (P28651)
    - *Macropus* sp. (2) (P28640)
    - *Macropus siva* (2) (P28385)
    - *Macropus titan* (2) (P28384)

Infraclass Eutheria
- Order Rodentia
  - Family Muridae
    - Subfamily Conilurinae
      - *Leporillus conditor* (1) (P30213)

Site 8

A single specimen, comprising the left ramus of *Sarcophilus laniarius* (P28404) was collected from this site.

Site 15

The partial skeleton comprising a metatarsal IV, distal end of humerus and numerous associated bone fragments (P30776) is referable to *Procoptodon goliah.* This specimen was collected by Mr. Hal Thomas at Boy Creek, Lot 22, Parish of Tulillah, Country of Millewa, on the property of Mr. J. Curtis, Karawinna, Victoria.

Site 1, Monoman Formation (late Pleistocene)

Grid reference 387,804

Stratigraphy

Grey argillaceous sands occur as superficial deposits at the site of the proposed Chowilla Dam. These belong to the Coonambidgial Formation. During excavation of Bore Hole 20, Line D and the Grout Curtain Excavation (Gill, This Memoir), a number of tree trunks were encountered at a depth of 9-11 m. One has been C14 dated at 7,200 ± 140 yr B.P. (GaK-2513). Wood from a depth of 8·3 m gave a C14 date of 4,040 ± 100 yr. B.P. (Firman 1971). At about the 9m level there is probably a disconformity (Gill, pers. comm.), below which occur well washed coarse sands to gravels extending down to a depth of greater than 24 m. These sands have been named the Monoman Formation by Firman (1967).

A portion of a right femur of *Phascolonus* cf. *P. gigas* missing the greater trochanter and distal condyles was obtained from a depth of 18·3 m in the Trial Trench for the Grout Curtain. This specimen is registered as V50 in the collection of the Geological Survey of South Australia. The same specimen had been previously identified as *Nototherium* (Firman 1971, p. 3). The greater portion of a vertebral centrum was collected from a depth of 22·3 m in the Bore Hole 20, Line D excavation. It agrees closely in morphology with the first lumbar vertebra of *Macropus ferragus* (P28568) from Lake Victoria, although the former is slightly superior in size.

On biostratigraphic grounds these sediments are tentatively placed as late Pleistocene.

Sites 7-9, Lake Victoria Sands (late Pleistocene-Holocene)

Grid reference (Site 7) 426,808-427,808
Grid reference (Site 8) 428,808-433,803
Grid reference (Site 9) 433,803-433,799

Stratigraphy

Fossil vertebrates of late Pleistocene age have been found in lunette sediments in New South Wales at Lake Victoria, Lake Tandou (Merrilees, This *Memoir*) and Lake Menindee (Tedford 1967).

Large erosion gullies transect the Lake Victoria lunette in an EW. or SW.-NE. direction. Some attain a depth of 11-12 m. They normally open only on the lakeward side and terminate in large cul de sacs toward the back or E. end.

Fossil mammals are most abundant along the NE. and N. edges of the lunette. No megafaunal species have been found along the SE. side, S. of Site 9. Fossil mammals are found in both members of the Lake Victoria Sands (for definition see Gill, This *Memoir*). In the upper member (Talgarry Sand) only living species (e.g. *Lasiorhinus krefftii, Bettongia lesueur, Onychogalea fraenata, Lagorchestes leporides, Leporillus conditor*) have been found, while both living and extinct species *(Procoptodon goliah, Protemnodon anak, P. brehus, Thylacoleo carnifex, Diprotodon optatum, Sthenurus atlas, S. andersoni, S. tindalei, Phascolonus gigas, Macropus ferragus)* are found in the lower member (Nulla Nulla Sand). The Talgarry Sand is Holocene in age while the Nulla Nulla Sand is late Pleistocene—early Holocene (Gill, This *Memoir*).

Two basic types of preservation were recognized. In the less consolidated crossbedded quartz sands most of the bone material is leached, chalky and delicate to handle. The bone is typically white, and speckled with small manganese dendrites. The more complete and articulated skeletal remains found were in this condition. Secondly, material found in the grey calcareous argillaceous layers, and as float on these layers, are typically encrusted with carbonate and sand. These specimens are usually impregnated with calcite and generally are more poorly preserved than specimens from the crossbedded quartz sands and consist largely of broken dental and podial elements.

Age

The Lake Victoria Local Fauna (see below) is composed of species which are generally recognized as representing a late Pleistocene age (Tedford 1967). A number of C14 dates were obtained on charcoal and shell samples from occupation sites of early man (see Gill, This *Memoir* for complete listing). One charcoal sample (GaK-2515) (15,300 ± 500 yr B.P.) was collected from a midden with which marsupial remains were associated. The bone material represents two dentary fragments of *Onycholgalea fraenata* (P28577, P29499). Apart from this single find, there is no evidence of a direct association of Aboriginal man with other mammal species. Several conclusions may be *inferred* from this evidence.

1. Megafaunal species and man occurred together at Lake Victoria but man did not prey on the larger forms.
2. Man did prey on the megafaunal species although no trace of this association has yet been found.
3. Megafaunal species were not contemporaneous with early man at Lake Victoria and the 18,200 ± 800 yr B.P. date (GaK-2514) (the oldest C14 date obtained on an occupation site of early man at Lake Victoria) sets a maximum date of disappearance and a minimum age for occurrance of the megafauna.

In the fossil collection from Lake Victoria 177 jaw and maxillary fragments are assignable to megafaunal species and represent a minimum number of 87 individuals. From the surrounding Lake district Blackwood and Simpson (This *Memoir*) have examined 67 Aboriginal skeletons, and numerous middens and ovens have been studied. There is no evidence of a direct association of man with the megafauna in any of these studies.

The number of individuals of both megafauna and Aboriginals examined is notably large and it would appear that had an association occurred some evidence would have been recognized. On this admittedly negative evidence the megafaunal species *appear* to have predated that of the earliest known Aboriginals at Lake Victoria, placing the age of the large Pleistocene fauna as pre-18,000 yr B.P.

There is, however, evidence that early man and the megafauna were contemporaneous in late Pleistocene time in other areas of the Murray Basin, indicating that the second inference may in fact be the most likely.

At Lake Mungo, N.S.W. (200 km E. of Lake Victoria) a human cremation was found in a level dated between 25,000 and 32,000 yr B.P. (Bowler et al. 1970). Tedford (1967) reports charred remains of the extinct macropod species *Macropus ferragus* in an Aboriginal oven C14 dated at 26,300 ± 1,500 yr B.P. at Lake Menindee, N.S.W. (240 km N. Lake Victoria) establishing association of early man with the late Pleistocene megafauna.

At the present time I am not convinced that it is possible to completely separate those specimens in the fauna which are of species represented by living forms which occcurred in direct association with the megafaunal species and those which have been added at a later date, and are thus younger in age. The type of preservation of the bone material has been relied upon heavily in sorting of the fossil material, and specimens of the living species which have carbonate encrustation and adhering sand are assumed to have occurred with the megafauna. Some of the species are definitely younger in age than the megafauna as all of the specimens referable to them lack all traces of carbonate encrustation (e.g. *Perameles bougainville, Isoodon auratus, Macrotis lagotis, Pseudomys gouldii*). The presence or absence of carbonate encrustation for each species is marked accordingly in the faunal list given below.

To add further chaos, most specimens were collected as float and because of this it was not possible to establish the exact provenance of the majority of the elements. In view of these problems I have thought it best to treat the entire fossil assemblage from the lunette deposit as representing a single fauna, including specimens from the Nulla Nulla and Talgarry Members of the Lake Victoria Sands. The age of this fauna is thus recognized as late Pleistocene-Holocene in age. I will discuss the spectrum of preservation of the specimens of each species separately at a later date.

The fossil fauna collected from the lunette sediments at Lake Victoria is here designated as the Lake Victoria Local Fauna.

Lake Victoria Local Fauna (late Pleistocene-Holocene)

The mammal species in the Lake Victoria Local Fauna are divisible into four major groups:

1. Megafauna species which are now extinct, e.g. *Thylacoleo carnifex, Phascolonus gigas, Sthenurus andersoni, S. atlas, S. tindalei, Protemnodon anak, P. brehus, Procoptodon goliah, Macropus ferragus,* and *Diprotodon optatum.*

2. Species occurring in the older late Pleistocene sediments apparently in direct association with the megafaunal species and still inhabiting the region today, or within historic times, e.g. *Bettongia lesueur, B. penicillata, Onychogalea fraenata, Lagorchestes leporides, Leporillus conditor.*

3. Species occurring in the older late Pleistocene sediments in direct association with the megafaunal species and represented by living forms not occurring in the area today, e.g. *Thylacinus cynocephalus, Lasiorhinus krefftii, Onychogalea lunata, Phascolarctos cinereus.*

4. Species present in the late Pleistocene sediments which represent larger, ancestral, Pleistocene forms of living species, e.g. *Sarcophilus laniarius, Macropus titan, Osphranter cooperi, Wallabia vishnu* representing larger Pleistocene forms of *S. harrisii, M. giganteus, O. robustus,* and *W. bicolor* respectively. A study of the relationships of the latter four lineages is in preparation. It should be noted that similar findings of "Post Pleistocene Dwarfing" have been reported for European species (Kurten 1959) and the concept of post Pleistocene dimunition in body size is regarded as representing "a general evolutionary trend" (Hooijer 1950).

The large number of browser and browser-graser species in the fauna (*Sthenurus andersoni, S. atlas, S. tindalei, Procoptodon goliah,* *Protemnodon anak, P. brehus)* suggests that the habitat in this area during at least part of lunette formation was more equable than occurs there today. It is most likely that a savanna-open woodland occurred in this area during these more equable periods.

The minimum number of individuals which would account for all of the identifiable tooth elements of each mammal species listed below was computed and is presented in Fig. 3 in the form of a Pie Diagram. This diagram expresses the relative abundance of each species represented in the collection studied from Lake Victoria *only,* and *should not be* interpreted as approximating the population structure during late Pleistocene time.

Class Pelecypoda
Family Hyriidae
Velesunio ambiguus

Class Crustacea
Order Decapoda

Crayfish gastroliths. A series of 12 specimens (P30198) have a mean diameter of 12.0 mm and an overall range of 7.8-21·4 mm.

Class Osteichthyes
Superorder Teleostei

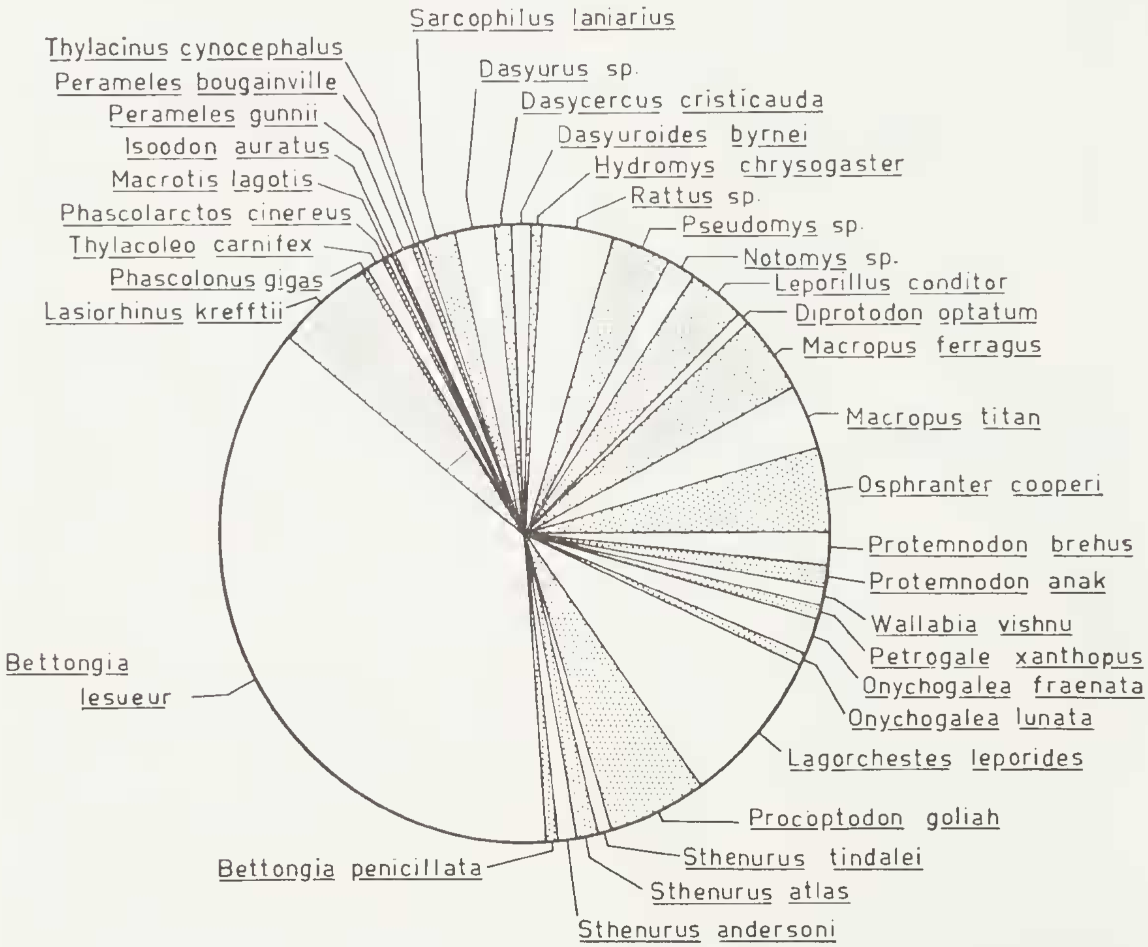

Fig. 3—Pie diagram showing the relative abundance of the mammal species collected from Site 7-9 (Lake Victoria Local Fauna) based on the minimum number of individuals that would account for all of the elements in the collection.

Numerous vertebral elements and spines of fish are represented. A series of five centra (P30200) measure: Breadth = 27·0-30·7 ($\bar{X}$ = 28·6), Depth = 22.4-24·6 ($\bar{X}$ = 23·4) these represent some of the larger centra in the collection.

Class Aves

Order Casuariiformes

Represented by large egg shell fragments, the curvature of which suggests a size comparable to a species of *Dromaeus*.

Unidentified small humerus (P30201)

Class Reptilia

Order Chelonia

Family Chelyidae

Plastron and carapace fragments.

Order Squamata

Suborder Lacertilia

Family Varanidae

Varanus cf. V. varius (P30206)

Family Scincidae

Tiliqua rugosa (P30202)

Very small species, genus indet. (P30205)

Family Agamidae

Amphibolurus cf. *A. barbatus* (P30203)

Amphibolurus cf. *A. muricatus* (P30204)

Suborder Ophidia

Large segment of articulated vertebrae. The head region was missing, but nearly 2 m of body was present.

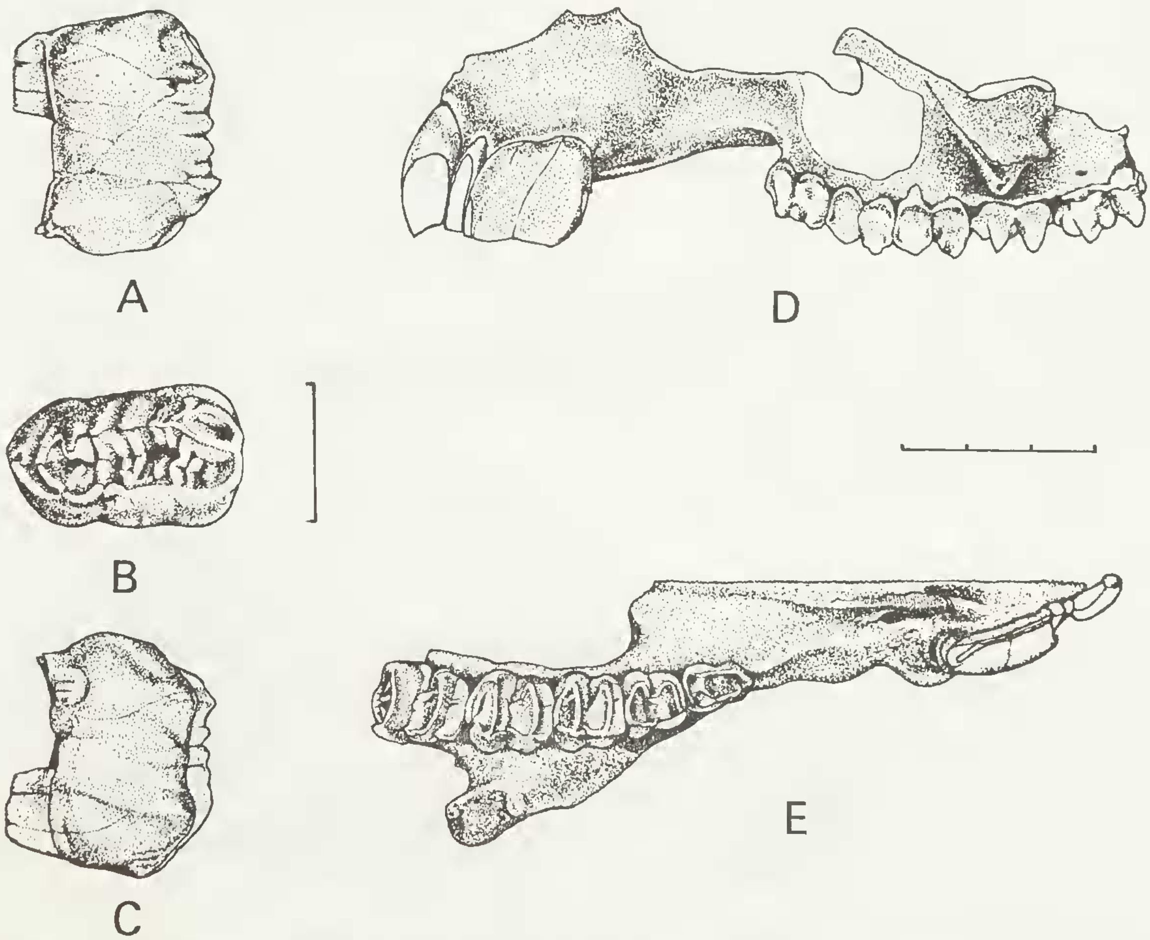

Fig. 5—*Sthenurus atlas* (P28267, Site 8). Left maxillary region with I$^{1-3}$, P^2, Dp^3, M$^{1-3}$ (D-E) and extracted P^3 (A-C). A = labial, B = occlusal, C = lingual, D = labial, and E = occlusal views.

Class Mammalia
Infraclass Metatheria
Superorder Marsupialia
Order Marsupicarnivora
Family Dasyuridae
§ *Dasyuroides byrnei* (P28263)
§ *Dasycercus cristicauda* (P28427)
§ *Dasyurus* sp. (P28265)
¶‡ *Sarcophilus laniarius* (P26544)
Family Thylacinidae
‡ *Thylacinus cynocephalus* (P26573) Pl. 1, fig. 1
Order Peramelina
Family Peramelidae
† *Perameles bougainville* (P28851)
§ *Perameles gunnii* (P28853)
† *Isoodon auratus* (P28850)
† *Macrotis lagotis* (P28849)
Order Diprotodonta
Family Phascolarctidae
* *Phascolarctos cinereus* (P28570)
Family Thylacoleonidae
‡ *Thylacoleo carnifex* (P29485)
Family Vombatidae
‡ *Phascolonus gigas* (P28844)
§ *Lasiorhinus krefftii* (P30179) Pl. 1, fig. 3
Family Macropodidae
Subfamily Potorinae
§ *Bettongia lesueur* (P28634-1) Pl. 1, fig 4
§ *Bettongia penicillata* (P29425)
Subfamily Sthenurinae
‡ *Sthenurus andersoni* (P28650)
‡ *Sthenurus atlas* (P28267) Fig. 4
‡ *Sthenurus tindalei* (P26547)
‡ *Procoptodon goliah* (P28279) Pl. 3, figs. 1-4
Subfamily Macropodinae
§ *Lagorchestes leporides* (P29453)
§ *Onychogalea lunata* (P28830)
§ *Onychogalea fraenata* (P28688)
* *Petrogale xanthopus* (P28768)
¶ *Wallabia vishnu* (P28666)
‡ *Protemnodon anak* (P28273)
‡ *Protemnodon brehus* (P28660) Fig. 5
¶ *Osphranter cooperi* (P28269) Fig. 6
¶ *Macropus titan* (P28632)
‡ *Macropus ferragus* (P28413) Pl. 1, fig. 2, Fig. 7
Family Diprotodontidae
‡ *Diprotodon optatum* (P26542)
Infraclass Eutheria
Order Rodentia
Family Muridae
Subfamily Murinae
§ *Leporillus conditor* (P29503-24)
§ *Notomys* cf. *N. mitchellii* (P29506-3)
§ *Pseudomys desertor* (P29505-6)
† *Pseudomys* cf. *P. gouldii* (P29501)
§ *Pseudomys australis* (P29504-5)
Subfamily Conilurinae
§ *Rattus lutreolus* (P29507-2)
* *Rattus* cf. *R. tunneyi* (P29508)
§ *Rattus* cf. *R. villosissimus* (P29509-18)
Subfamily Hydrominae
* *Hydromys chrysogaster* (P28566)

* All specimens referable to these species have carbonate encrustation.

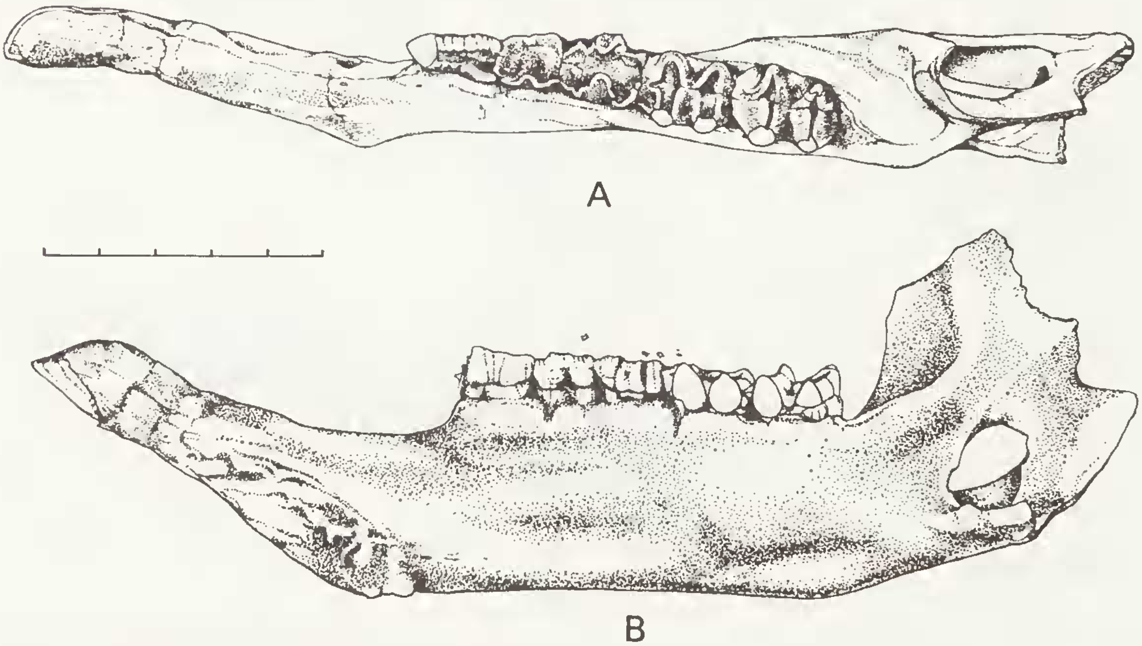

Fig. 5—*Protemnodon brehus* (P28660, Site 8). Right ramus with lower incisor, P_3 missing anterior edge, M_{1-4}. A = occlusal, B = lingual views.

† All specimens referable to these species lack carbonate encrustation.
‡ Extinct on the Australian mainland. All specimens have carbonate encrustation.
§ Some of the specimens assignable to these species lack carbonate encrustation and were probably not directly associated with the extinct megafaunal species.
They are probably no older than Holocene.
¶ Larger late Pleistocene ancestral form of living species.

Summary

Placing an absolute age on the vertebrate bearing deposits in the Lake Victoria region and correlating them directly with previously known deposits from Australia and New Guinea presents a major problem which is beyond the range of this study. It is deemed best to place these deposits and their faunas in a tentative time sequence only. Thc age of the faunas as based on both biostratigraphic and rock-stratigraphic grounds as determined by Gill (This *Memoir*) are in close agreement and for this reason the latter study serves as a check on the chronologies set forth here.

As presently recognized the Nulla Nulla Sand and Monoman Formation are of late Pleistocene age. The first is aeolian, the latter fluviatile. The Rufus Formation is shown by Gill (this *Memoir*) to be older than the Nulla Nulla Sand. An unconformity separates the Rufus Formation from the underlying Blanchetown Clay. The length of the hiatus is unknown although it is judged to be of considerable

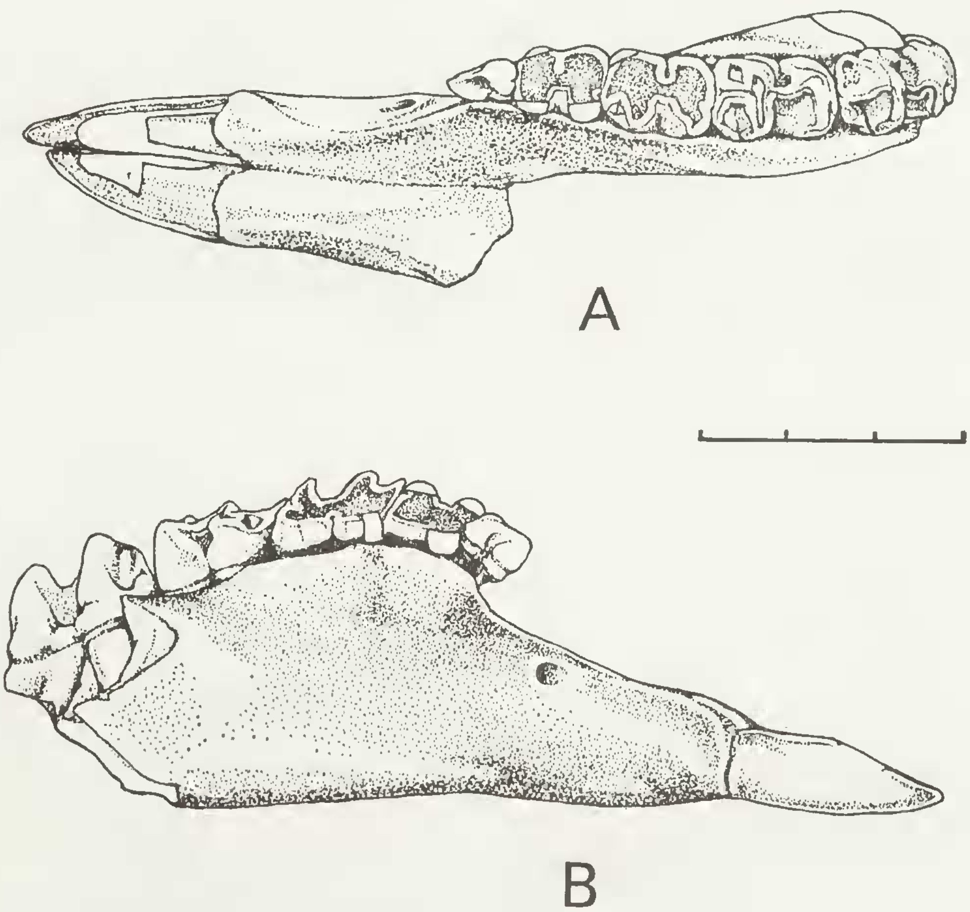

Fig. 6—*Osphranter cooperi* (P28269, Site 8). Right ramus and diastemic portion of left ramus with lower incisors, right P_3, M_{1-3}, M_4 erupting. A = occlusal view, B = labial view.

duration in the study area. The Fisherman's Cliff Local Fauna is comparable in age with the fauna from the late Pliocene or early Pleistocene Chinchilla Sand in SE. Queensland.

The Lake Victoria lunette at Sites 8-9 contains up to four paleosols separated by layers of fine to medium grained quartz sands. A basically similar stratigraphy is reported for the Lake Mungo lunette (Walls of China) (Bowler 1971). The presence of multiple paleosols indicates that a substantial period of time was involved in lunette formation. Bowler (1971) has shown that lunette formation at Lake Mungo has occurred intermittently over the past 40,000 years.

The climate during at least a portion of lunette formation at Lake Victoria was probably more equable than occurs in the area today. This is based on the presence of such woodland species as *Phascolarctos cinereus* and *Wallabia vishnu* (10% larger ancestral late Pleistocene form of *W. bicolor*) which to obtain a congenial environment in this region of the Murray River Basin today "would need the rainfall to double and the appropriate woodland vegetation to migrate westward perhaps 500 km" (Calaby 1971, p. 87). In addition, the presence of a large number of browser and browser-grazer species such as *Procoptodon goliah, Sthenurus andersoni, S. atlas, S. tindalei, Protemnodon anak,* and *P. brehus* suggests that a savanna-open woodland habitat once existed in the Lake Victoria area.

The localities and faunas described here are important because of the clear superpositional relationship of the different fossil bearing units and of the abundance and diversity of the faunas contained in them.

Comparison of Fig. 2 (this paper) with Fig. 2 in Stirton et al. (1968) will place the faunas

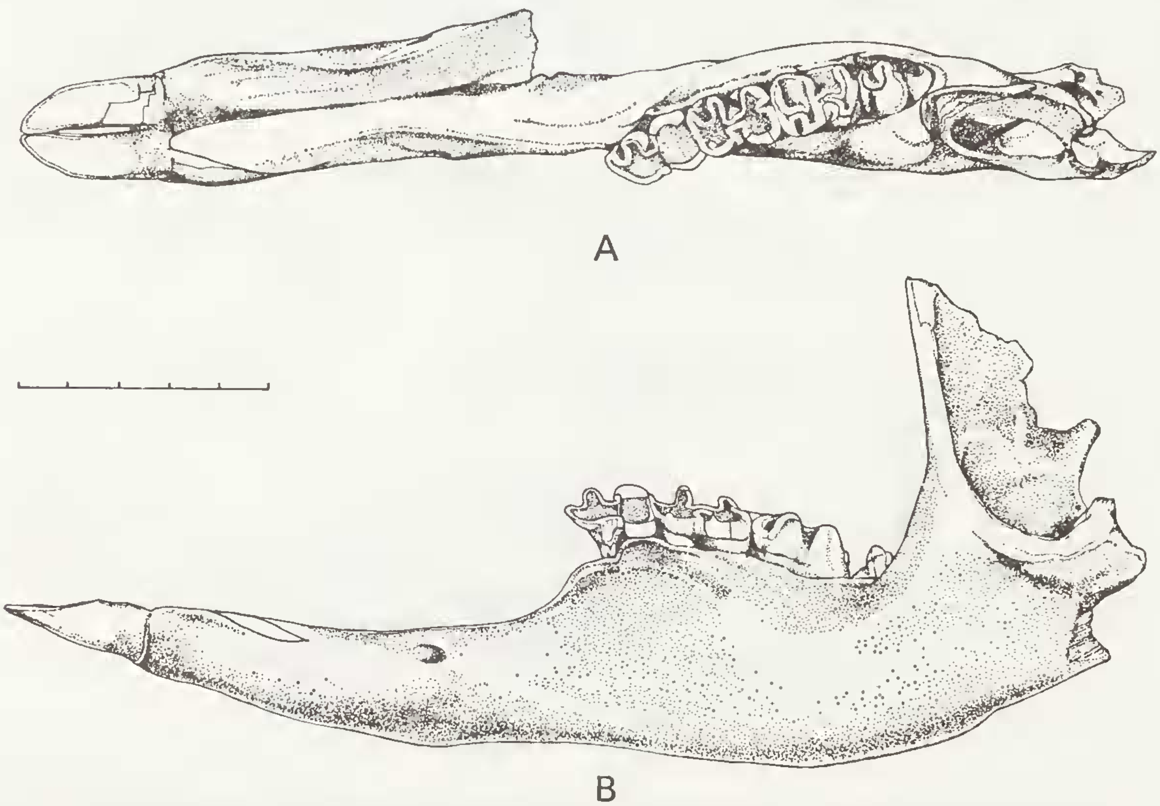

Fig.7—*Macropus ferragus* (P26537, Site 8). Left ramus and diastemic portion of right with lower incisors, left M_{1-3}, M_4 erupting. A = occlusalview, B = labial view.

discussed here in perspective with those from other Australian and New Guinea localities (also see Stirton et al. 1961).

Comments on Early Man and the late Pleistocene Megafauna

The term megafauna is *generally* applied to those large species of terrestrial vertebrates which became extinct at the end of the Pleistocene. The mammal species include *Procoptodon goliah, Sthenurus atlas, Protemnodon brehus, Phascolonus gigas, Diprotodon optatum* and *Macropus ferragus* to name just a few. There are also species in late Pleistocene deposits which represent larger forms of smaller sized living species. These were previously recognized as representing extinct species and hence included, by definition, with those species already listed. The best understood (unpublished data) of these species is *Macropus titan* which represents a 30% larger late Pleistocene form of the living species *M. giganteus,* and *Osphranter cooperi* (including as synonomies *M. birdselli* and *M. altus*) representing a 25% larger late Pleistocene form of the living species *O. robustus.*

The late Pleistocene species megafauna is thus divisible into two major components (1) extinct species and (2) species which experienced a post-Pleistocene dimunition in body size. In the latter the late Pleistocene forms seemingly become extinct, and the living forms (which are not found in direct association with the extinct megafaunal species) appear in deposits less than 20,000 yr in age, in which extinct megafaunal species are absent.

Tedford (1967) reports the charred fourth metatarsal of *M. ferragus* from an Aboriginal oven at Lake Menindee, N.S.W., establishing a direct association with early man with the megafauna. Both *M. ferragus* and *M. titan* are present at Lake Menindee (unpublished data). I have found (unpublished data) that the fourth metatarsals assigned by Tedford (1967) to *M. ferragus* and the fourth metatarsals of a *M. titan* sample from the late Pleistocene chocolate clays at the Keilor Terrace archaeological site (Gallus excavation), Victoria, are inseparable morphologically and metrically. How then does this bear upon the reported association at Lake Menindee, and for that matter associations elsewhere as well?

To base an association on forms which undergo post-Pleistocene dimunition in body size does not necessarily prove contemporaneity with the extinct members of the megafauna, as the dwarfing forms certainly outlived the extinct forms. It is apparent that an association with extinct megafaunal species must be based on one of these species and not on species like *M. titan* or *O. cooperi* which gave rise to smaller living forms. Based on this evidence, which of the species does the Lake Menindee metatarsal belong to, the extinct *M. ferragus* or the dwarfed *M. titan*? The former would establish an association of Aboriginal man with the extinct megafaunal species, the latter would not. Recongnition of this problem is of primary importance in defining associations of Aboriginal man with the late Pleistocene megafauna.

Acknowledgements

As my part in this project was initiated just over a year ago, many individuals deserve credit for their generous help and guidance during preparation of this paper. Special thanks to Mr. Edmund D. Gill, Deputy Director of the National Museum of Victoria, Professor James W. Warren, and Mr. Ken Simpson of Monash University, Dr. Richard H. Tedford of the American Museum of Natural History, and Mr. Mike Archer, Western Australian Museum, for their constructive criticisms of the manuscript. For help with collections, my thanks to Sir Robert Blackwood, Mr. Tom Darragh, Curator of Fossils of the National Museum of Victoria, and Mr. Ken Bell, Assistant Curator of Fossils. Appreciation is due Dr. Richard H. Tedford, Mr. Alan Bartholomai, Director of the Queensland Museum, Mr. J. A. Mahoney, Geological Department of Sydney University, Mr. H. E. Wilkinson, Geological Survey of Victoria, Mr. Mike Archer, Dr. Jeanette Hope, Department of Prehistory, A.N.U., and Mr. M. Plane, Bureau of Mineral Resources, Canberra, for advise regarding taxonomic and biostratigraphic problems.

For their courtesy in allowing access to the study areas, my sincere thanks to Mr. T.

Honner (Moorna Station), Mr. Stephen and Trevor Hadlow (Talgarry Station), Mr. D. Harvey (Nulla Station) and Mr. R. Duncan (Dunedin Park Station). I am indebted to Miss D. Harrison for her help with the illustrations and in preparation of the photographs for publication. The line drawings were done by Miss Marion Kaighin. To the many who accompanied us on one or more of the many trips, my deepest thanks.

Addendum

The vertebrate fauna from Site 13 is presently being studied by Mr. Peter Crabb of the Zoology Department, Monash University, who began work on this fauna in May of this year (1972). In addition to the material listed in this paper may now be added 58 rodent molars, another species of dasyurid, smaller than any of the specimens discussed here, and a second species of peramelid cf. *Chaeropus*.

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Explanation of Plates 14-16

Plate 14

Fig. 1—*Thylacinus cynocephalus* (P26573). Partially excavated skeleton, in situ, Site 9.

Fig. 2—*Macropus ferragus* (P28290). Partially excavated hindlimb region, in situ, Site 8.

Fig. 3—*Lasiorhinus krefftii* (P30187). Scattered but associated dental and cranial elements, float, Site 8.

Fig. 4—*Bettongia lesueur*. Skull, in situ.

Plate 15

Figs. 1-2—*Glaucodon* cf. *G. ballaratensis* (P28684). Isolated left M^2, stereopair, Site 13.

Figs. 3-4—*Glaucodon* cf. *G. ballaratensis* (P28268). Left ramus with M_{1-4}, stereopair, Site 13.

Figs. 5-6—*Dasyuroides* sp. or *Dasycercus* sp.? (P28888). Right ramus with M_{2-4}, stereopair, Site 13.

Fig. 7—*Protemnodon* cf. *P. otibandus* (P28266). Left ramus with broken P_3, M_{1-4}, labial view, Site 13.

Figs. 8-9—Peramelid (P28686). Right M^2? 8, lingual view; 9, labial view, Site 13. Note the five well developed stylar cusps.

Plate 16

Figs. 1—*Procoptodon goliah* (P28279, Site 9). Occlusal view of mandible with left and right lower incisors, P_3, M_{1-4}.

Figs. 2-4—*Procoptodon goliah* (P28861, Site 9). 2, dorsal view of left pes with metatarsal IV, metatarsal V (y), mesectocuneiform (x), cuboid, navicular, astragalus, and calcaneum; 3, medial view of same. 4, lateral view of right pes with proximal end of metatarsal IV, cuboid and metatarsal V (y). Note the reduction in metatarsal V (y) and fusion of ectocuneiform, mesocuneiform, and entocuneiform into mesectocuneiform (x). These changes result in a functionally monodactylous pes.